

Phytotechnology Studies for Passive Groundwater Management at a Closed Waterfront Landfill: Lessons Learned

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Environment
Canada

Environnement
Canada



Outline

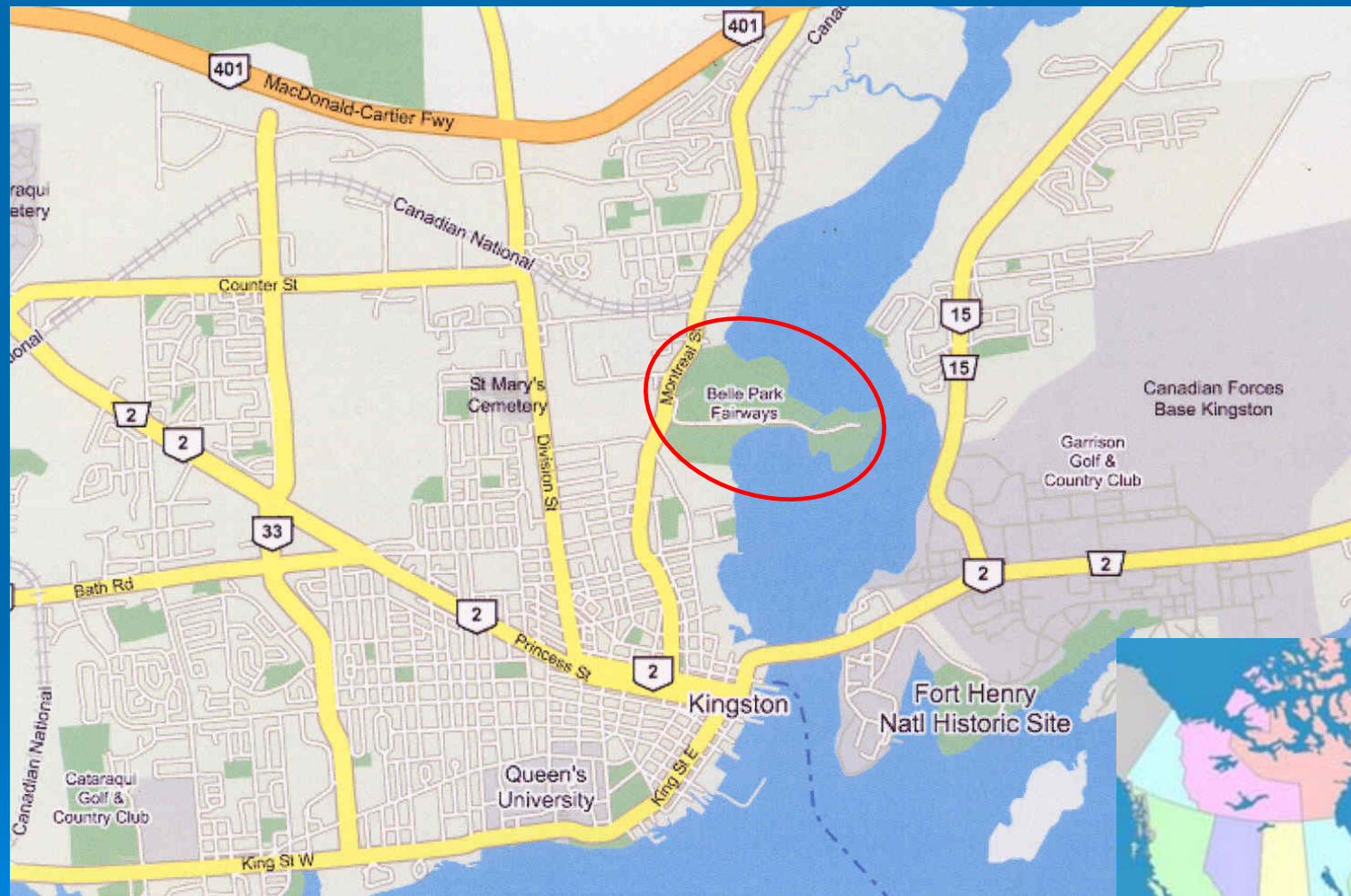
➤ Site

- Setting & History
- Current Site Management

➤ Studies

- Constructed Wetland
- Phreatophyte Tree Plots
- Instrumentation of Mature Trees

Site Location



Landfill Development

1953



1962



1971

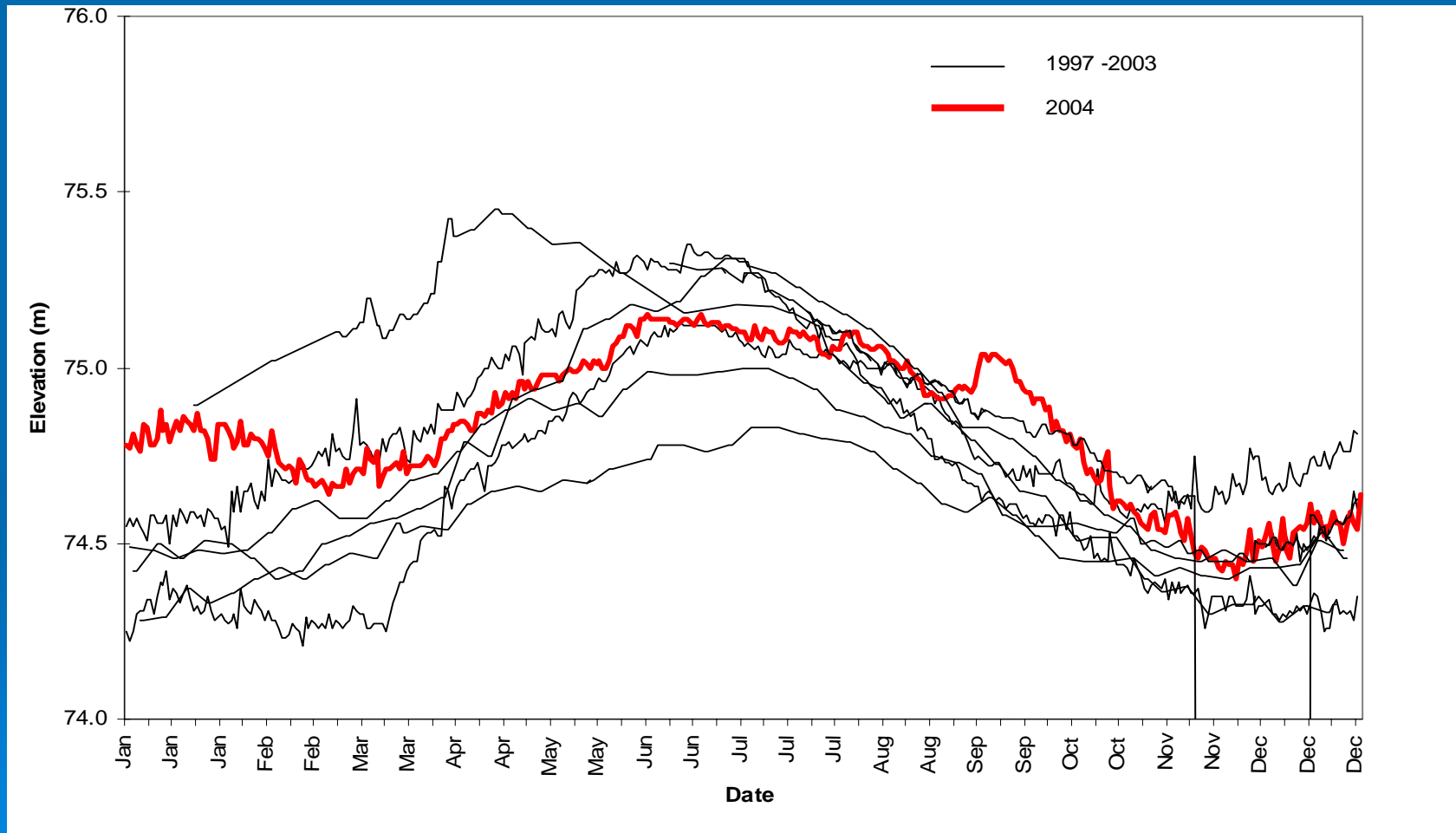


Current Conditions

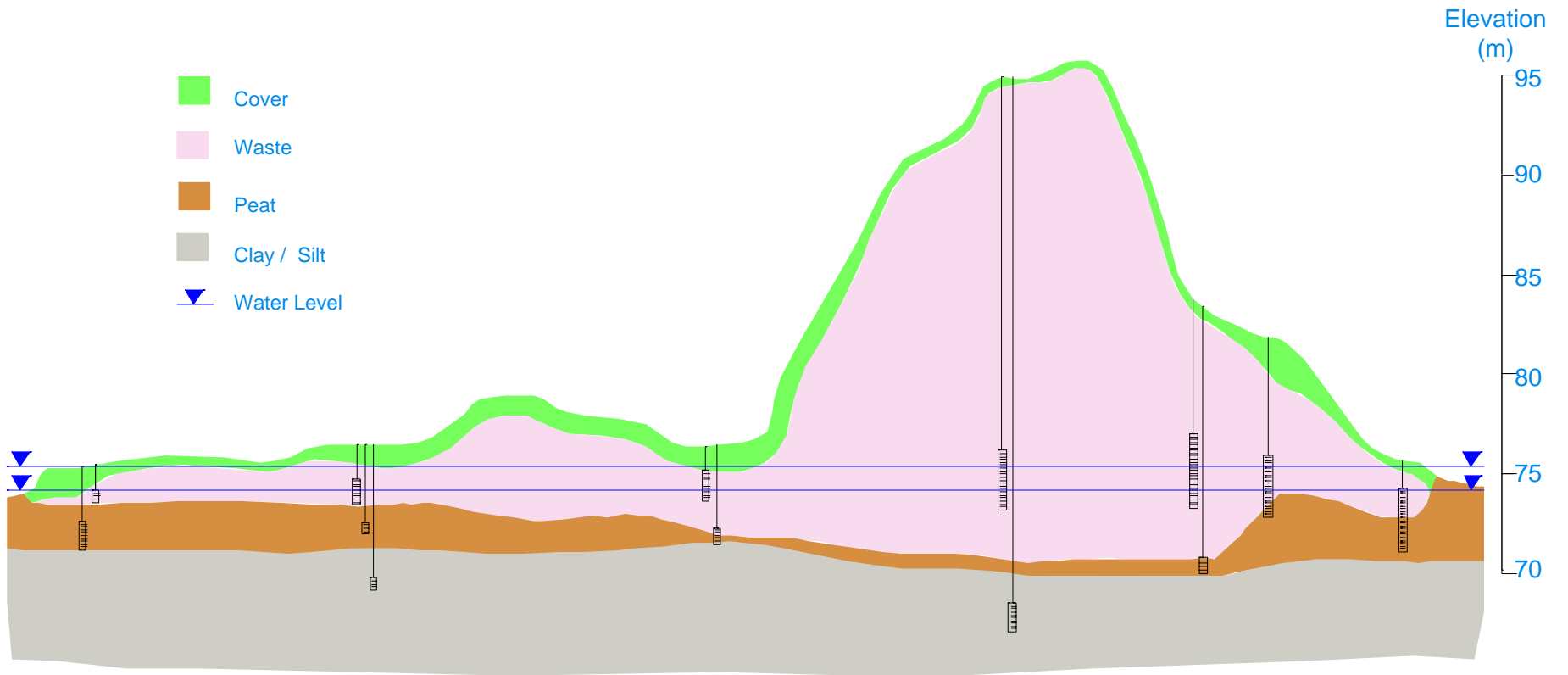


Source: City of Kingston

River Elevations (masl)



Site Characterization



Current Site Management

- Weekly Site Observation Visits
- Periodic Sampling
- Active Groundwater Pumping



Groundwater Pumping

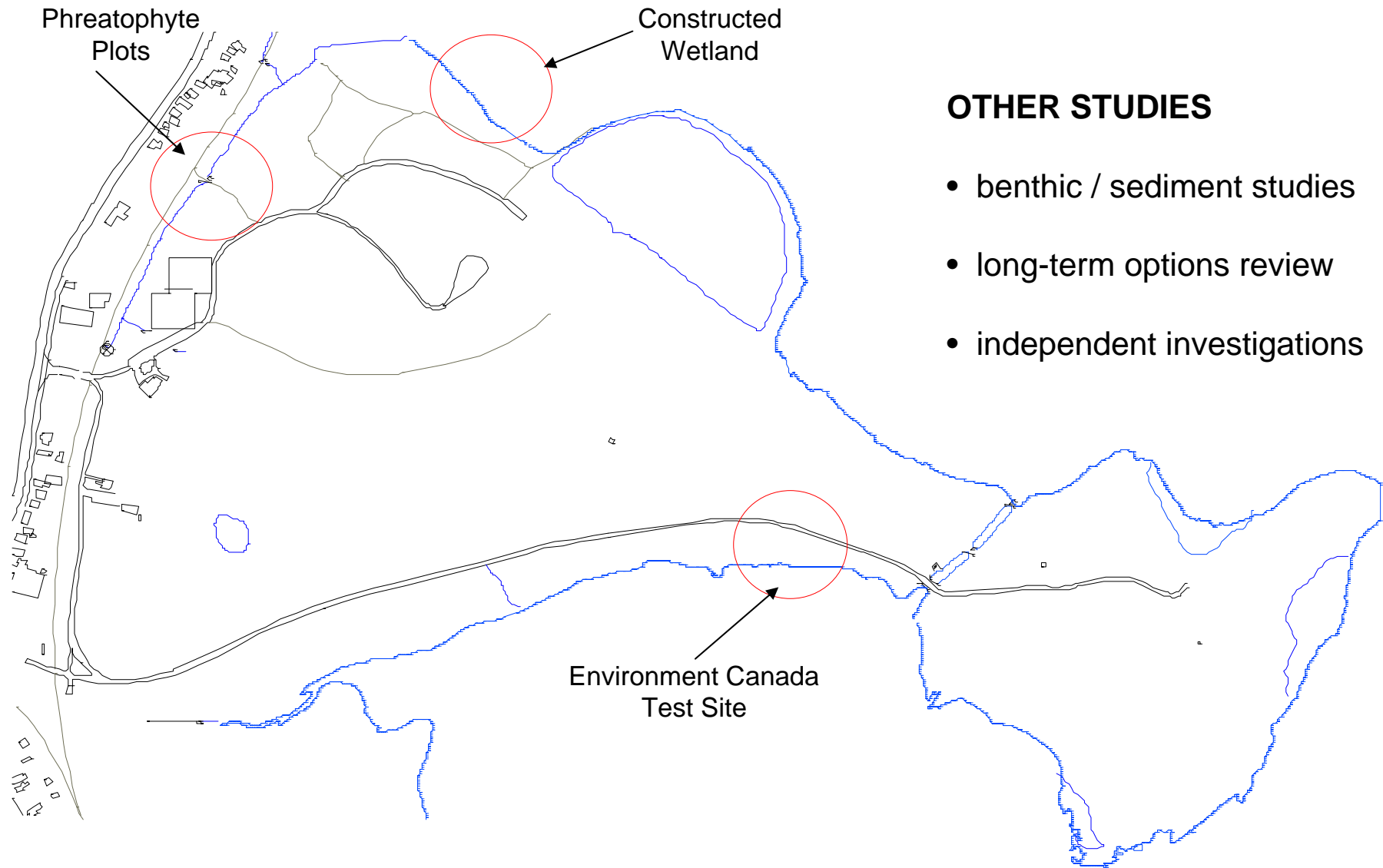


Groundwater Extraction

- active seepage management
- labour intensive
- water taking by permit
- costly



Feasibility Studies



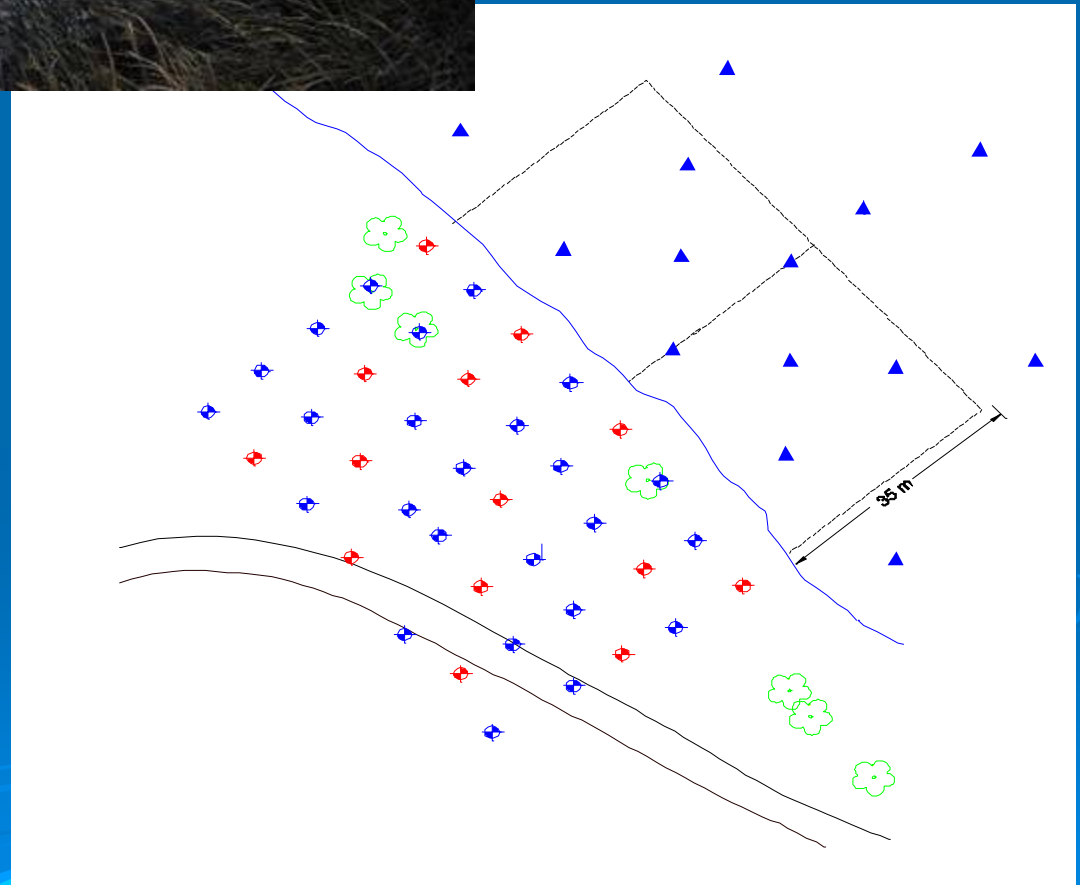
OTHER STUDIES

- benthic / sediment studies
- long-term options review
- independent investigations

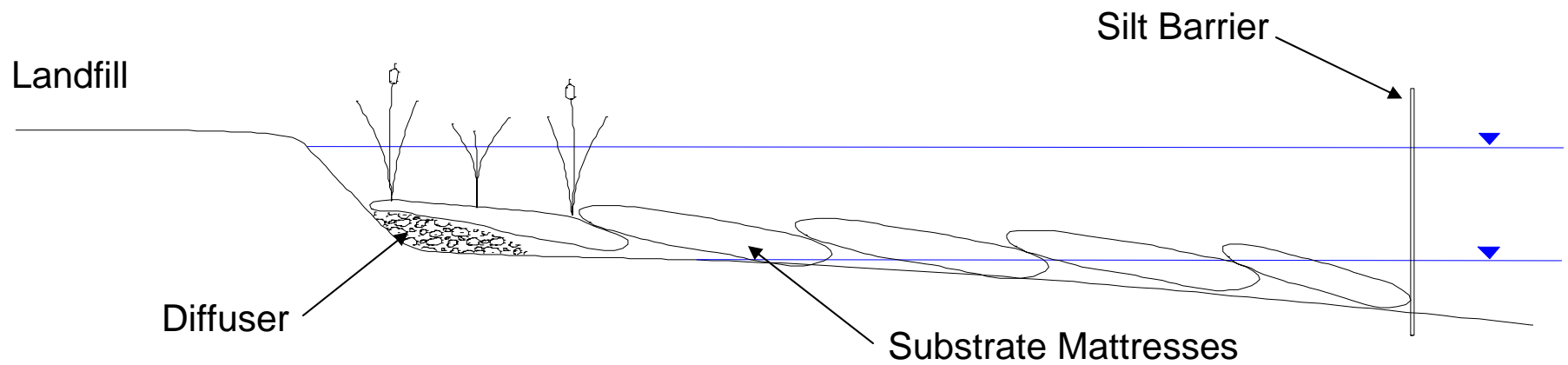
Constructed Wetland



- shallow fringe wetland
- in-water construction
- 2 - 35 m x 35 m cells
- cattails vegetation



Constructed Wetland – Schematic Section



Constructed Wetland - Monitoring

➤ Quarterly sampling

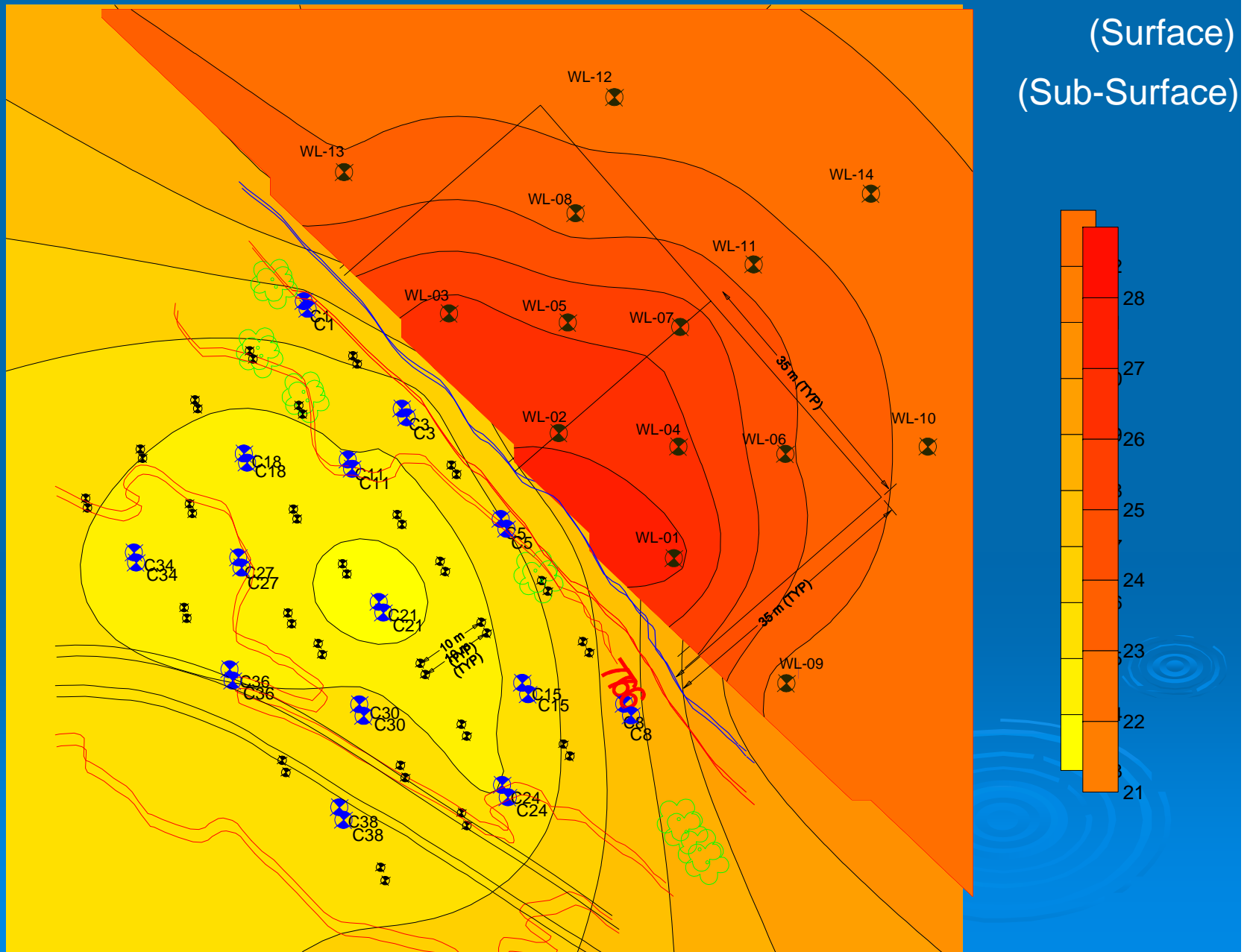
- surface water
- substrate
- groundwater

➤ Chemical Analyses

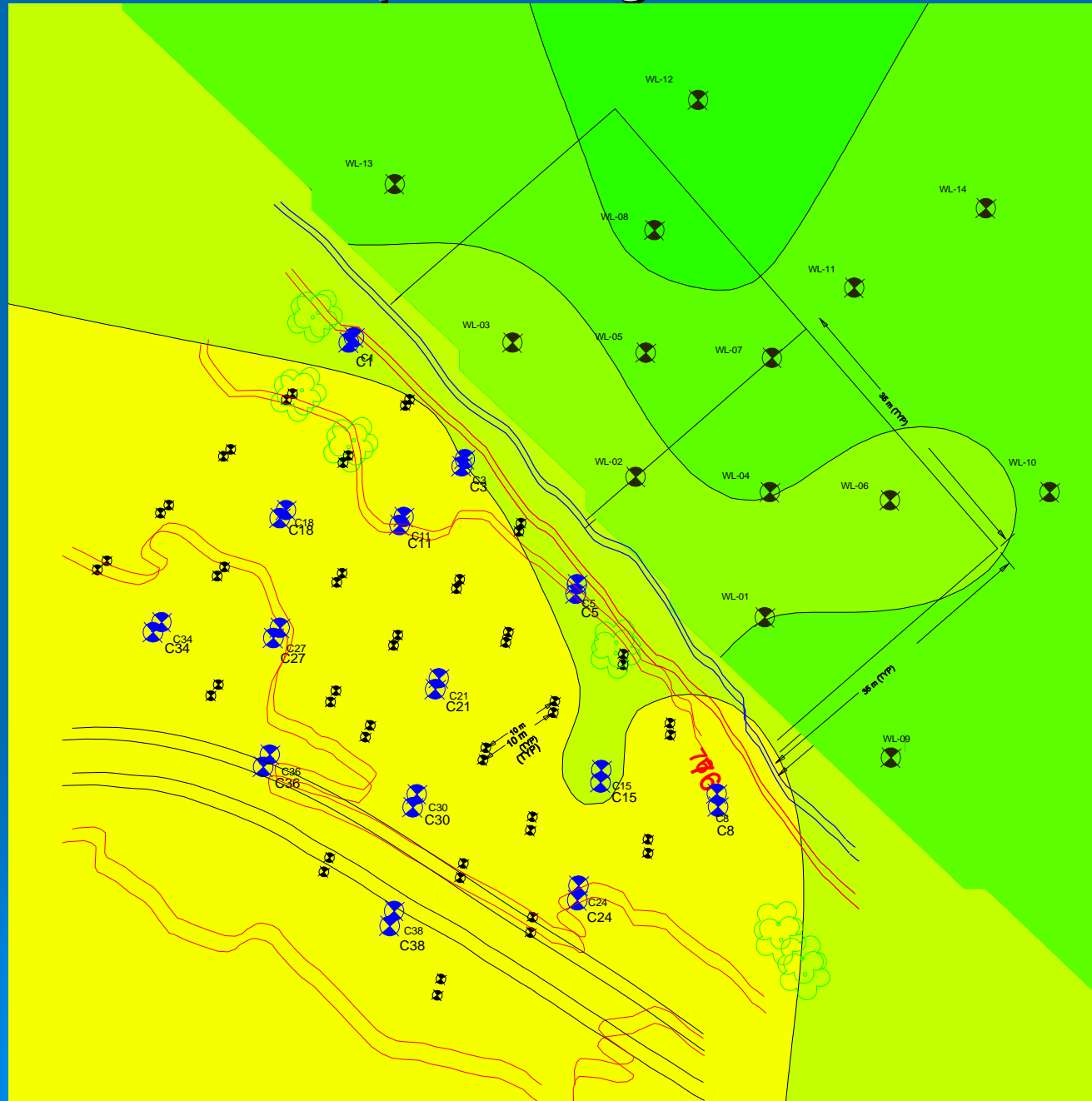
- nitrogen
- iron
- indicators



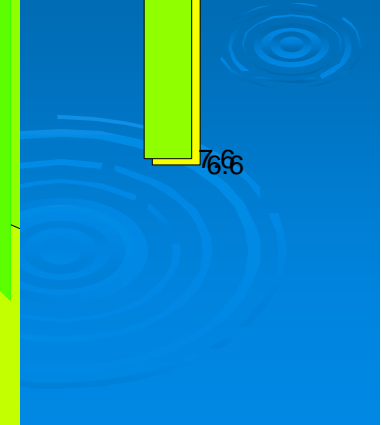
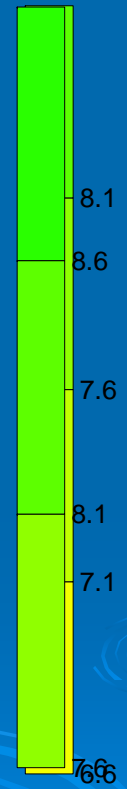
Temperature: Aug., 2004 (° C)



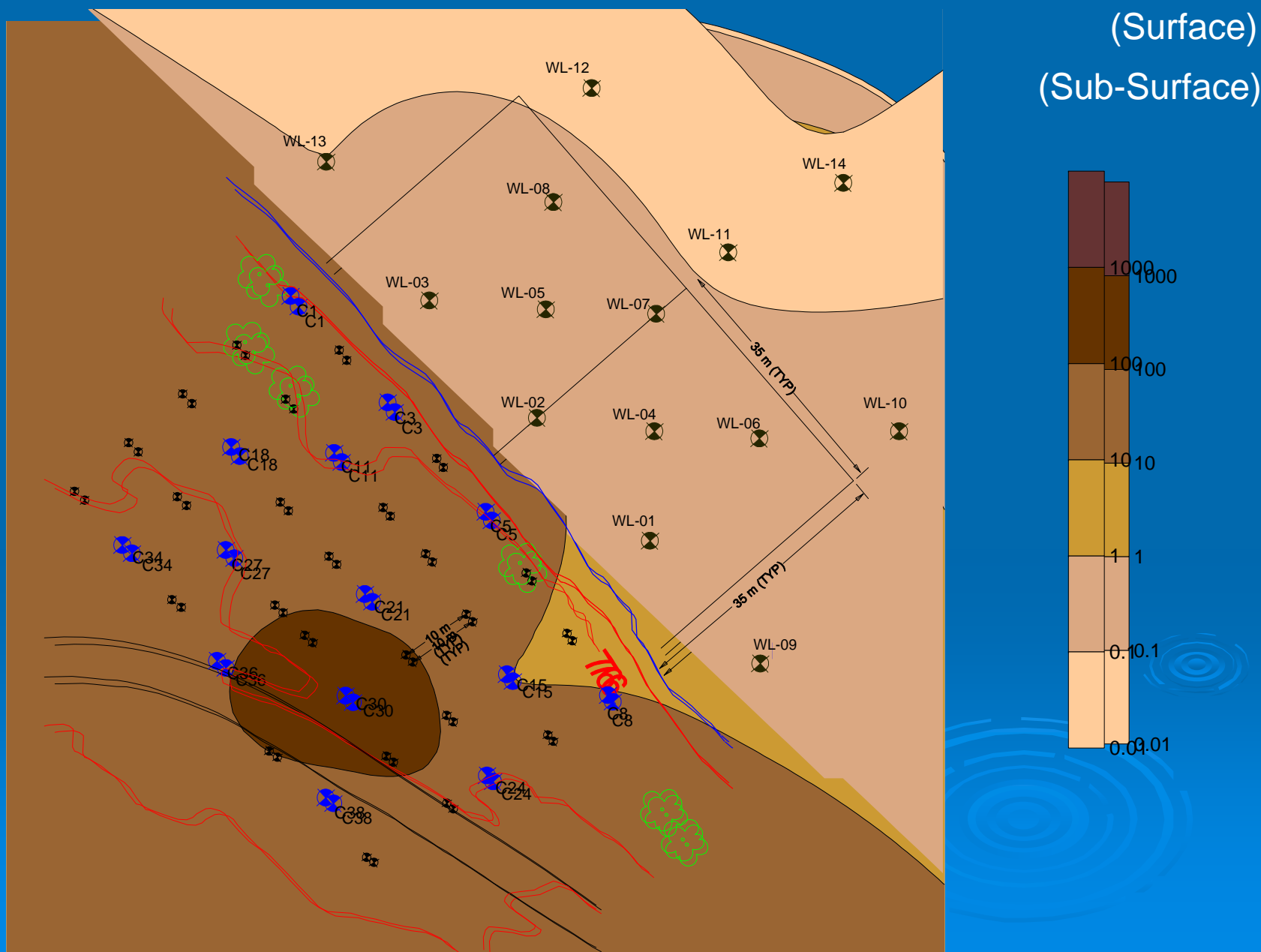
pH: Aug., 2004



(Surface)
(Sub-Surface)



Iron: Aug., 2004 (mg/L)



Constructed Wetland: Challenges & Opportunities

- cattails (from seeds & rhizomes)
- grasses, sedges, rushes
- limited growth after 2 seasons
- diffuser is a barrier to advance
- seed germination in growing stations
- transplanting opportunities
- populated by birds, fish, amphibians

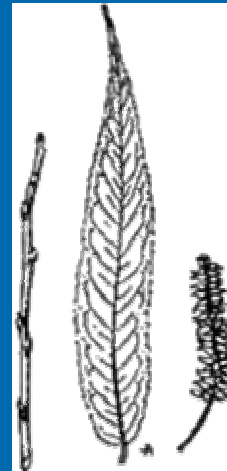


Phreatophyte Tree Plots



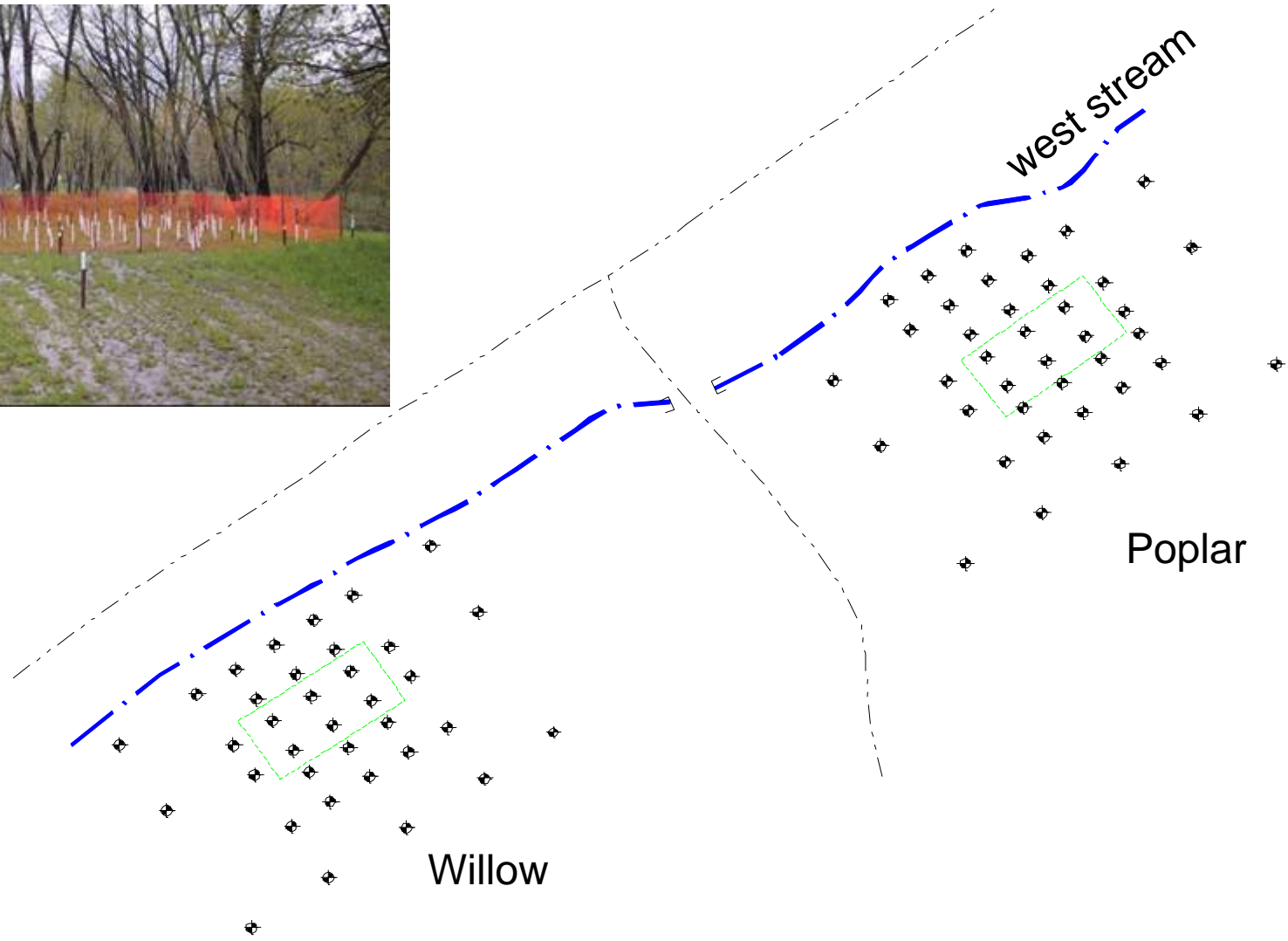
Phreatophyte Tree Plots

- *Salix nigra*
(black willows)
- *Populus balsamifera*
(balsam poplars)

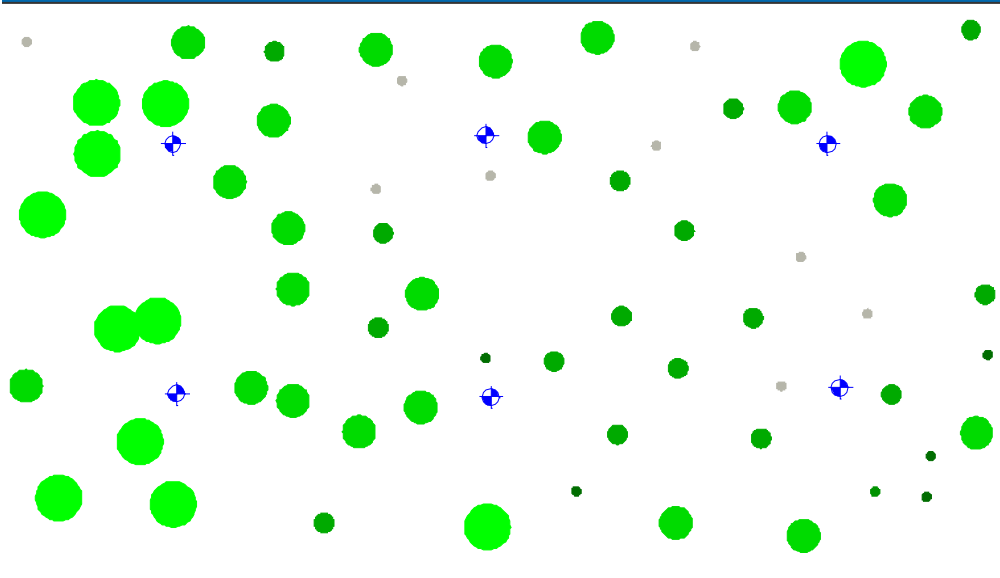


- hydraulic control of shallow groundwater
- native species
- willows already on-site

Phreatophyte Tree Plots

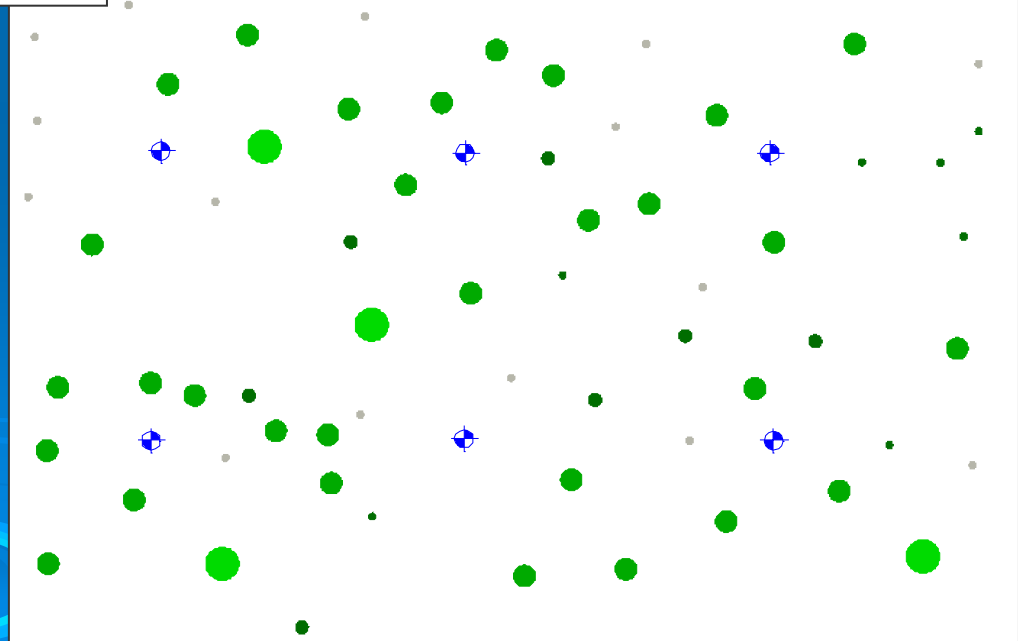
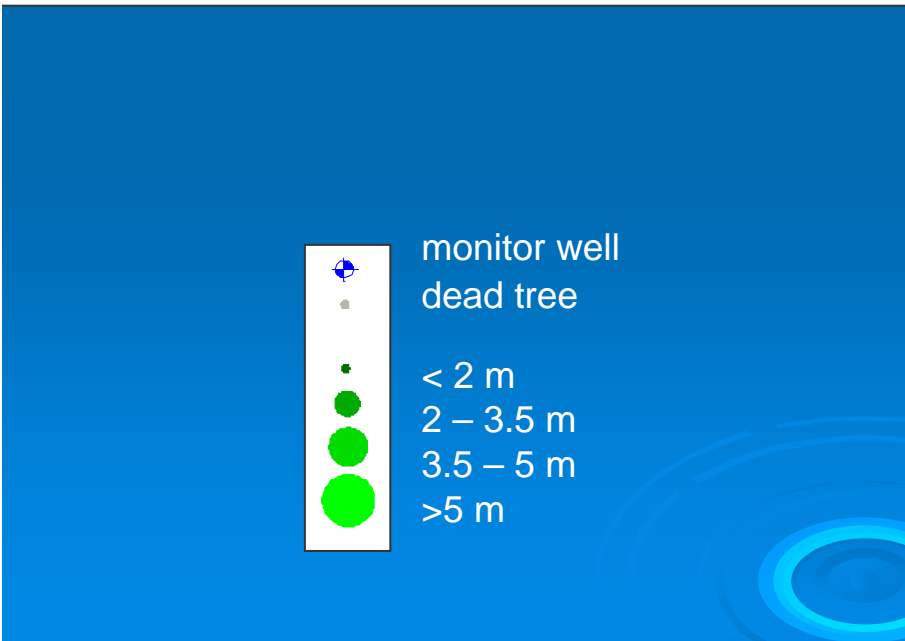


Tree Heights: Oct., 2004



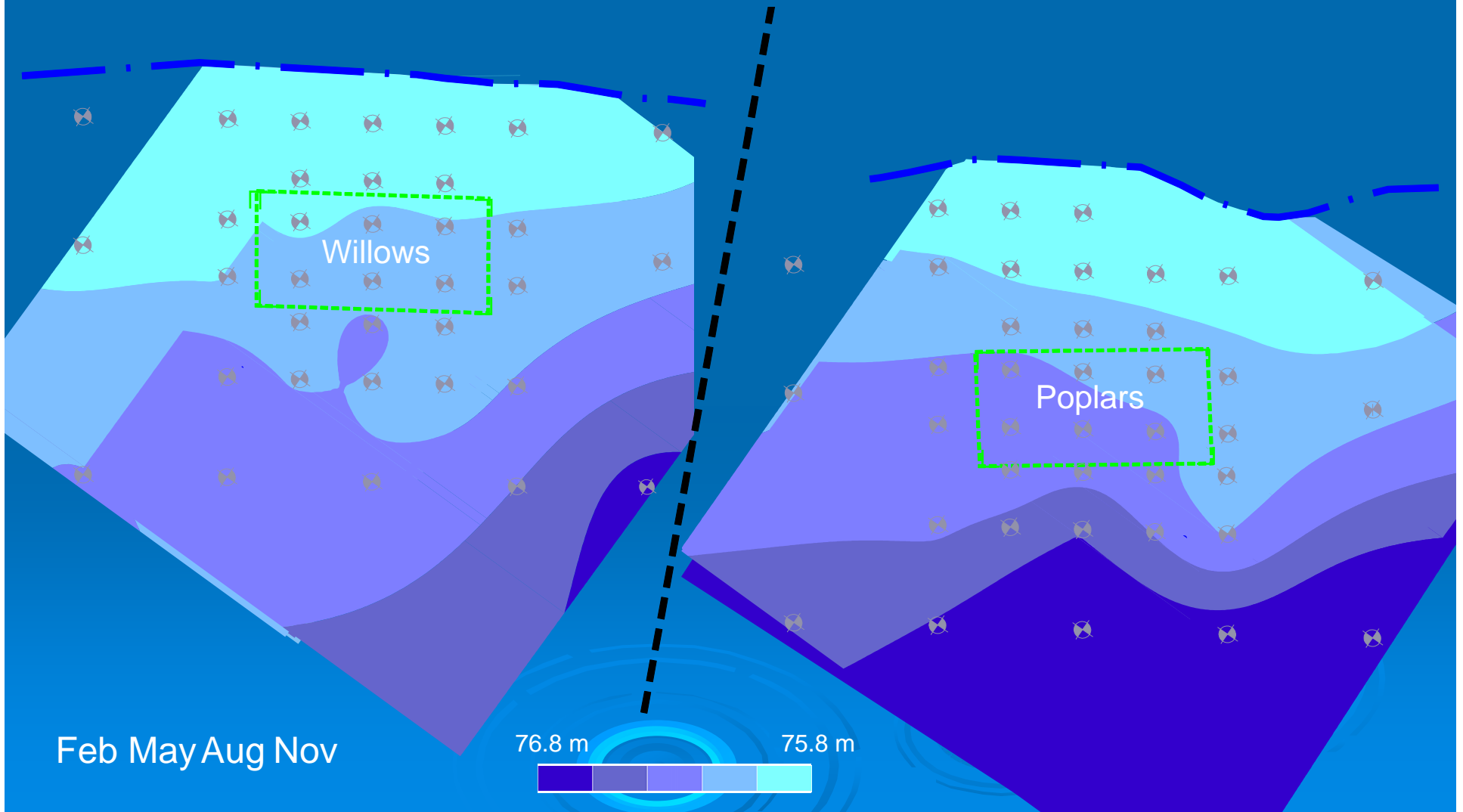
Willows

Poplars

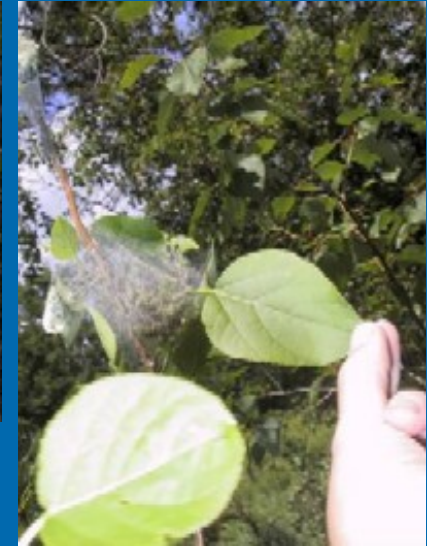


Groundwater Elevations: 2004

(contours = 0.2 m)



Phreatophytes: Challenges & Opportunities



Weather

Shoot Blight

Caterpillars

Vandalism

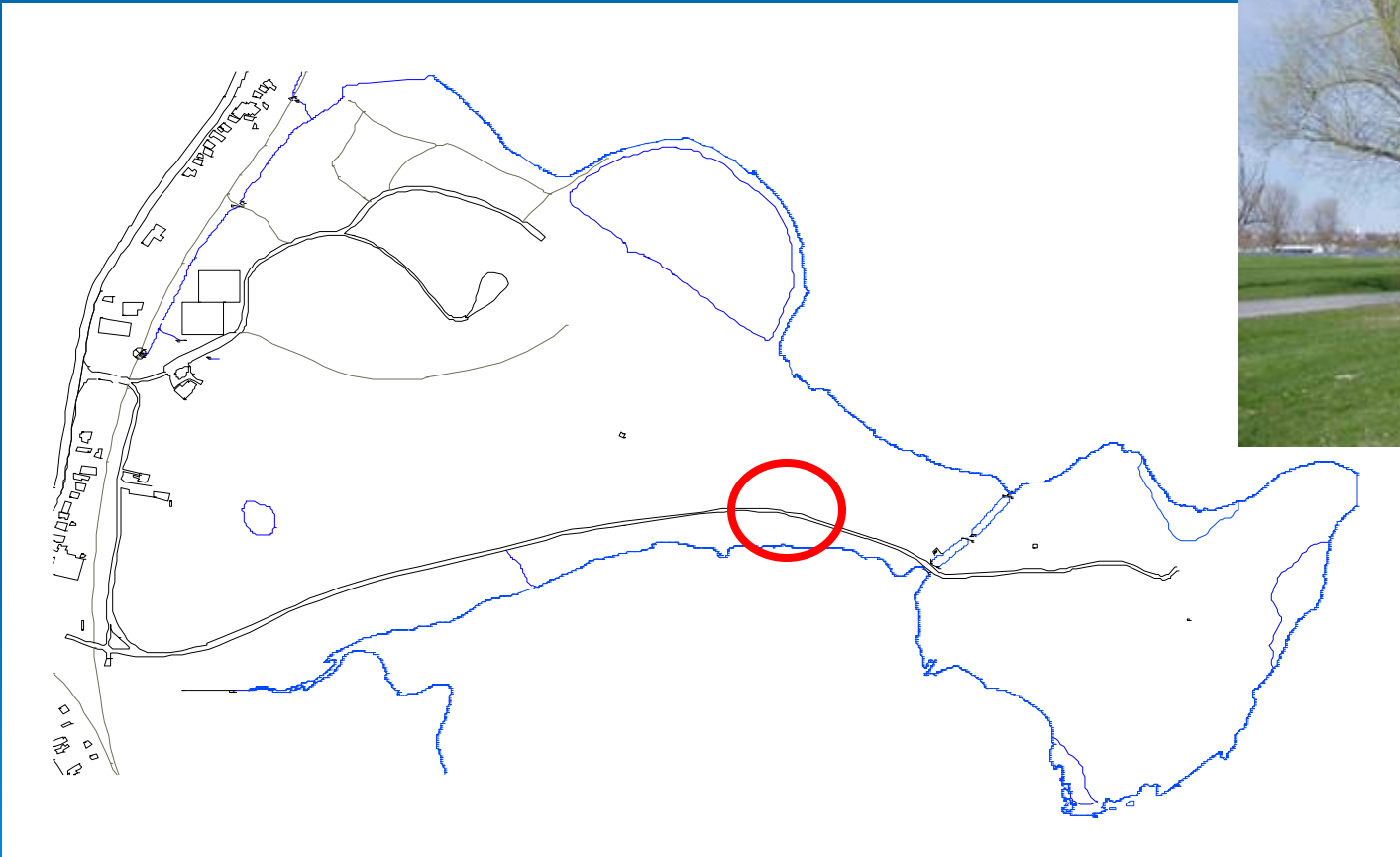
Viable Plants

Available Space

Mature trees on-site

Environment Canada Test Site

Instrumentation of 2 mature willows



Sap Flow Probes

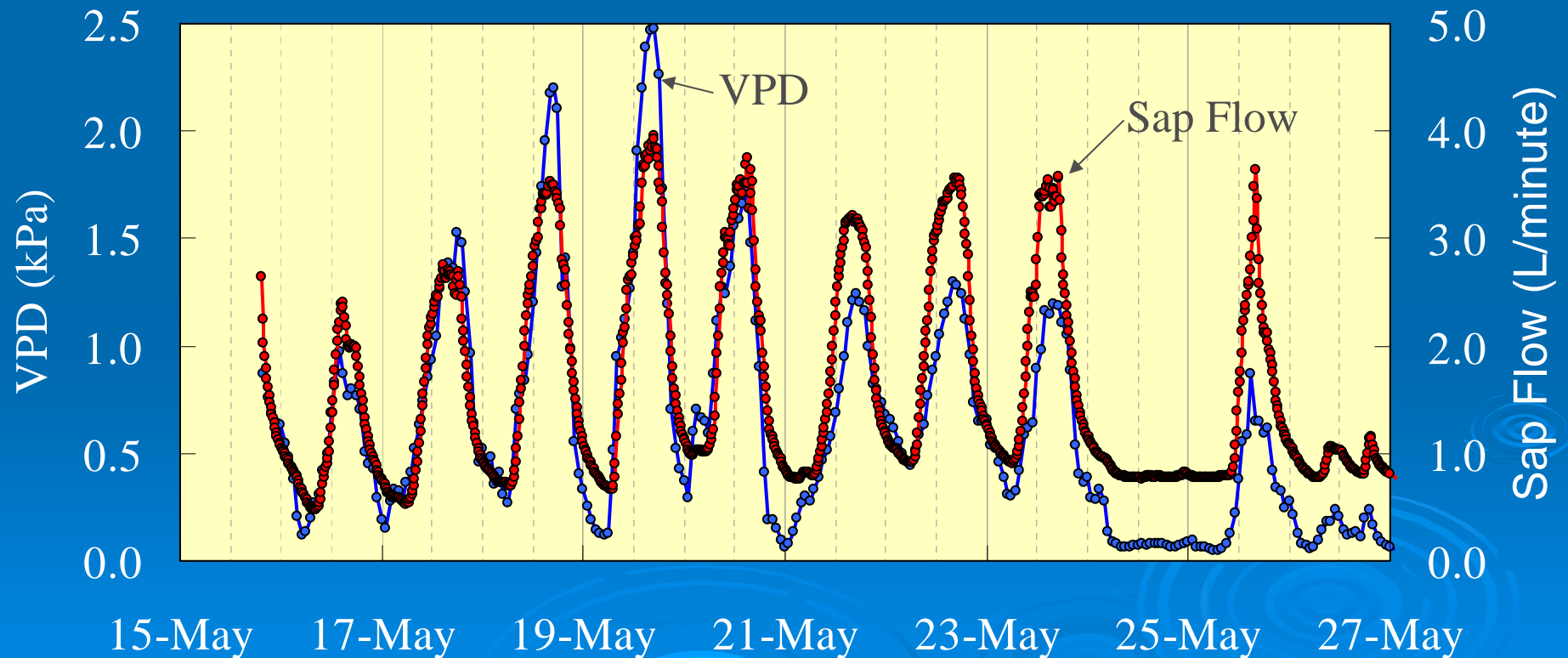


Based on correlation between sap flow and rate of heat dissipation in sapwood

Sap Flow & Vapour Pressure Deficit

Vapour pressure deficit (VPD)

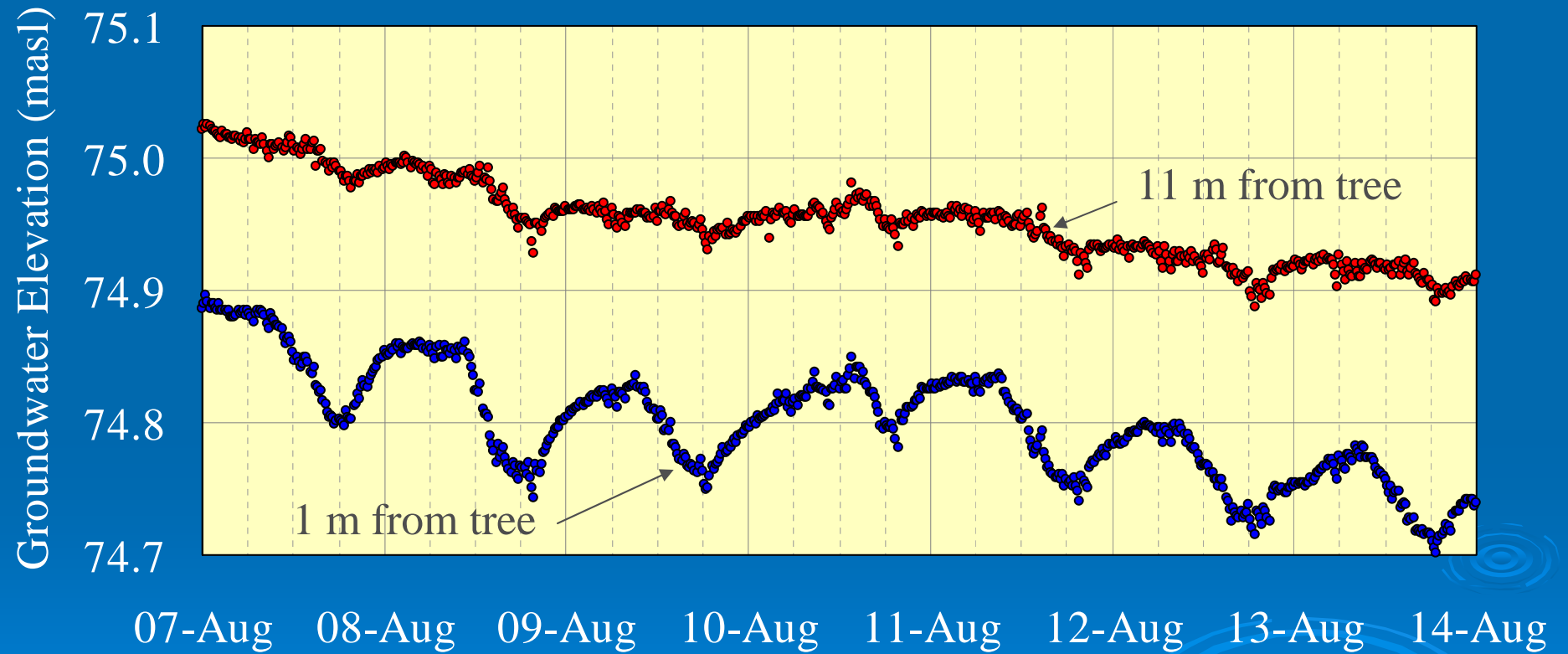
= difference between current amt of moisture in air & amt at saturation



Monitoring Well with LeveLogger



Water Level Fluctuations



Results of Measurements

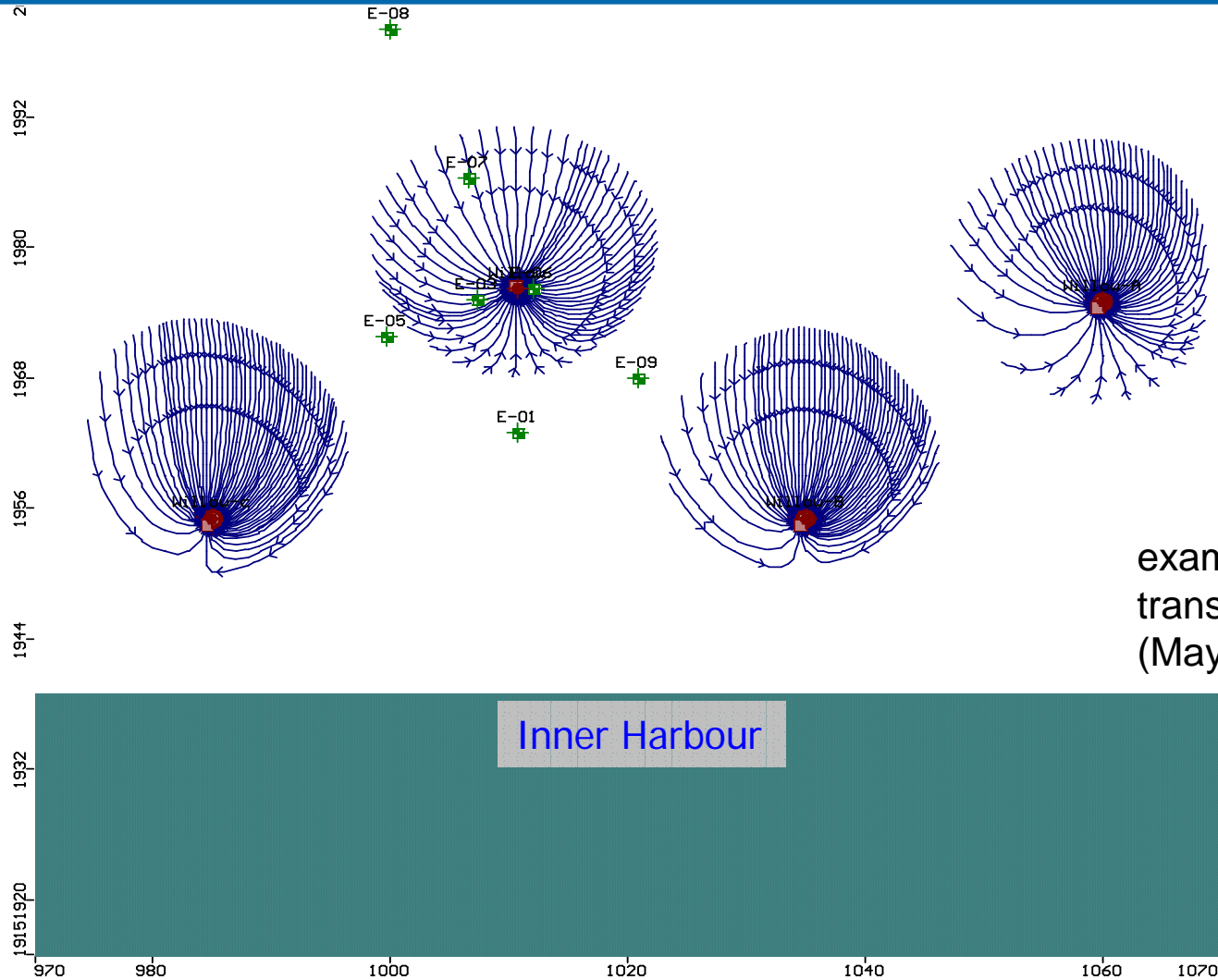
➤ Sap Flow:

- diurnal patterns
- ~ 1,200 to 3,000 L/day (May)

➤ Groundwater Fluctuations:

- diurnal patterns (but not in May)
- numerical modelling ~20,000 L/day
(appears to violate theoretical maximum)
- order of magnitude discrepancy with sap flow measurements

90-Day Capture Zone Analysis



Conclusions

- Studies are important inputs to:

Evaluation of Long-term Management Options

- Hydraulic control is promising (time dependent)
- Additional challenges to populating the wetland

Funding:

Canadian Biotechnology Strategy,
Environment Canada,
City of Kingston

Information:

City of Kingston

www.cityofkingston.ca/bellepark/

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